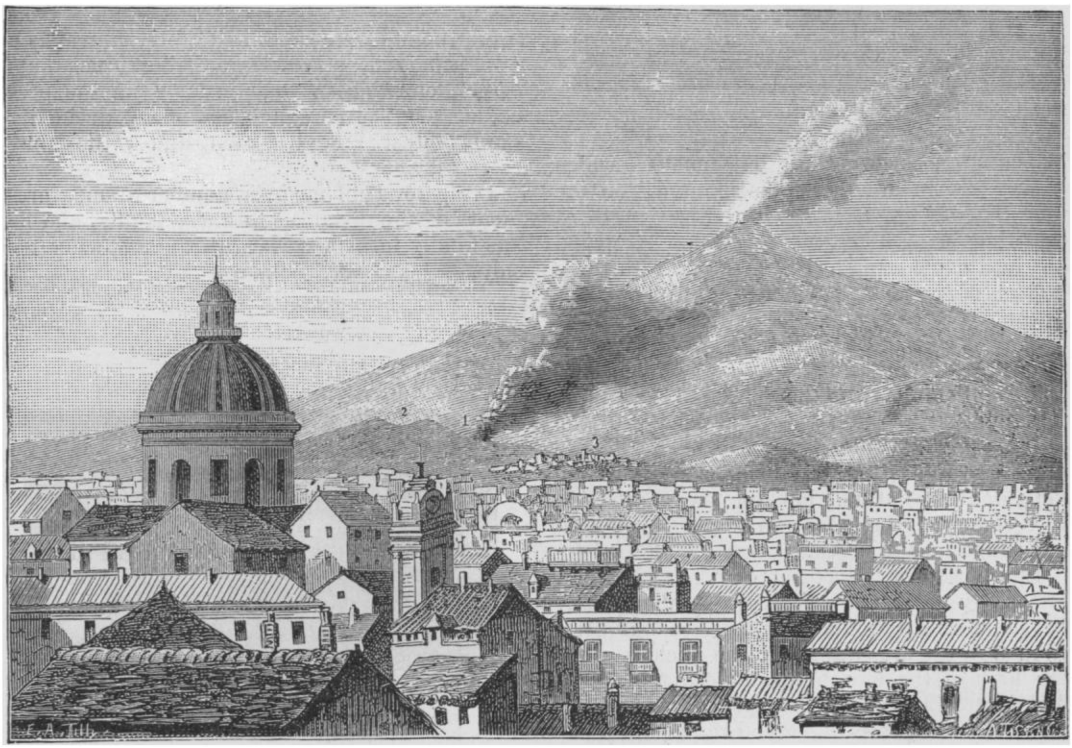
THE ERUPTION OF MOUNT ETNA.[1]

THE last eruption of Mount Etna, although slight, has some interest, in that it was at a point farther down the mountain than any other in recent times, and the only one which has occurred on the southern side in this century.

The first warnings of the threatening eruption came from a series of earthquake shocks on the morning of March 20. Low underground sounds were heard, the reports succeeding one another at intervals of a few minutes. It was not until evening that it became evident where the eruption was to take place. At that time flames broke forth on the lower part of the southern side, about on the edge of the cultivated zone, and four kilometres north of the village of Nicolosi. Large clouds of vapor and gases escaped from cracks in the earth, and enveloped the mountain in a dense fog. By night-time a very red and bright light, which, viewed from Catania, appeared to play in large waves around the foot of the mountain, announced the appearance of lava. Eleven cracks formed during the night; and from them were thrown scoriae, which formed three heaps forty to fifty feet high. One jet of scoriae was thrown out with such violence that the shock caused the bells in the villages of Nicolosi and Pedara to ring.



ERUPTION OF MOUNT ETNA, MARCH 22, 1883. VIEW TAKEN FROM CATANIA.
1. The point of eruption; 2. Monti Rossi; 3. Village of Nicolosi.

The consternation of the people was the greater, as the locality was the same as that of the great eruption of 1669. This point commands a sloping plain which is highly cultivated, and on which are living, within a short distance of the centre of the eruption, a population of twenty thousand.

The second day the character of the eruption became decidedly alarming. Some new fissures opened near Nicolosi, and the lava spread out in large waves over the neighboring country. This made the outlook very threatening; but, to the great surprise of all versed in the history of volcanic action, the eruptive movement began to abate, and during the night stopped entirely. This was fortunate, as the overflow of lava was from a point which might have caused great injury.

[1] Reproduced, with some modifications, from *La Nature* of April 14, together with the illustration.

The fact cannot be concealed, however, that the eruptive apparatus of this last upheaval has been left in a state which furnishes a constant menace to the neighboring villages. On account of the sudden cessation of action, the secondary phenomena have not taken place, by which nature usually brings about a permanent end to these parasitic craters. It is, then, among the possibilities of the near future, that another eruption may take place on the same spot where the late one has proved abortive.

MAGNETO-MOTIVE FORCE.

"Faraday compared a magnet to a voltaic battery immersed in water;[1] and he established by experiment the principal analogies on which this comparison is founded." Mr. R. H. M. Bosanquet, from whom the above is quoted,[2] thinks that too little has been made of this analogy, which seems to him to furnish the only sound view of magnetism. He would speak of a permanent magnet as possessing a certain 'magneto-motive force,' which, acting through a circuit made up of the magnet and the bodies or medium surrounding the magnet, produces throughout this circuit a total magnetic induction, equal to the quotient of the magneto-motive force by the 'magnetic resistance.' So-called magnetic substances are those in which the *magnetic conductivity* is great; and bodies of this sort, when brought near a magnet, become parts of the magnetic circuit, whose resistance they lessen, just as masses of metal placed in the water forming part of an electric circuit would lessen the total electrical resistance of such a circuit.

Moreover, a new distribution of the lines of magnetic induction is brought about by the entrance of the magnetic body into the field; this body receiving and transmitting a larger proportion of the lines of magnetic induction than the space it now occupies received and transmitted when filled by air. The body is now said, in ordinary terms, to be magnetized. At the same time, the lines of magnetic induction, being deflected from their most direct course, and bunched together where they approach the magnetic body to enter it, encounter in that region an increased air-resistance. A like condition of things exists in the air-region where they are departing from the magnetic body; and the effect of these increased air-resistances is to make the number of lines of magnetic induction through the body less than it would otherwise be. This air-resistance near the surface has for its equivalent in the ordinary theory the 'demagnetizing' action which the induced magnetism of a body exerts upon the interior particles of the body itself.[3] In the case of a very thin disk, magnetized by induction in a direction normal to its surface, the ordinary theory says that the demagnetizing action of the free magnetism of the surfaces almost neutralizes within the disk the effect of the external magnetizing forces, so that the magnetic induction in the disk is scarcely more intense than that in the air about it. The other theory explains the fact by saying that the superior magnetic conductivity of the disk is not able, acting for so short a distance, to seriously affect the course of the lines of induction in its neighborhood by making it advantageous for these lines to bend from their normal course in order to pass through the disk.

[1] Exp. res., iii. § 3276. [2] Phil. mag., March, 1883.
[3] Faraday, Exp. res., iii., § 3289; Maxwell, arts. 426 and 438, old edition.

Mr. Bosanquet's article is an attempt to prepare Faraday's theory for use in numerical calculations by furnishing it with exact quantitative definitions, and to show by the results of experiment that the theory is fitted for such work. In doing this he thinks it necessary to make essential changes in well-known and widely received formulas.

Mr. Bosanquet states the ordinary theory thus: "Now, the fundamental hypothesis at the base of the ordinary mathematical theory of magnetism is, that there are magnetizing forces $\mathfrak{H}$ which are of the dimensions of the magnetic induction $\mathfrak{B}$ which they produce, and that the magnetizing force permeates every medium, and produces in magnetic media magnetic induction proportional to the force and to a co-efficient of permeability μ, quite independently of the existence of any magnetic circuit." To this Mr. Bosanquet objects; one of his objections being, that "we have to suppose that the magnetizing force $\mathfrak{H}$ within a magnetic body has the power of remaining separate and distinct from the magnetic induction as a whole, though the two are quantities of the same nature." In his theory "the quantity $\mathfrak{H}$ becomes merely the magnetic induction in vacant space, and $\mathfrak{B}$ that in magnetic matter. $\mathfrak{B}$ replaces $\mathfrak{H}$, and is not supposed to include it as before."

Instead of remaining

$$\mathfrak{B} = \mathfrak{H} + 4\pi\mathfrak{I}, \text{ or } \mu = 1 + 4\pi\kappa,$$ [1]

"our fundamental equation becomes

$$\mu = 4\pi\kappa, \text{ or } \mathfrak{B} = 4\pi\mathfrak{I}."$$

The formula

$$\mathfrak{B} = \mathfrak{H} + 4\pi\mathfrak{I}, \text{ or } \mu = 1 + 4\pi\kappa,$$

adopted by Maxwell and others, might, according to Mr. Bosanquet, lead to serious errors. Thus in a sphere of infinite magnetic permeability, magnetized by induction, Stefan, he says, has shown that "the ratio of the number of lines of force through its equatorial section to the number through the same section in air" is 3. Practically the same result is obtained from one of Thomson's papers, and Mr. Bosanquet confirms these results by a calculation in accordance with the views he is advocating.

He attempts now to show that Maxwell, using the formulas above, would make this ratio 4 instead of 3. A similar error would, he thinks, occur in calculating, according to Maxwell, the corresponding ratio for the case of a disk of infinite conductivity.

However interesting and suggestive certain parts of Mr. Bosanquet's paper may be, there is little doubt that he has here met the usual fate of those who attempt to convict Maxwell of error in reasoning. It is easy to show that Maxwell's formulas are in complete accord with the result above obtained from Stefan and Thomson. Thus (p. 66, vol. ii., old edition) Maxwell says that "in the case of a sphere the ratio of the magnetization to the magnetizing force is . . ., and if κ were infinite the ratio would be as 1 to 4.19," etc. This result Mr. Bosanquet quotes, but from that point he goes wrong. On the next page of Maxwell, where he is discussing the demagnetizing forces which the poles of a magnetized body exert upon the 'interior particles' of the body itself, we read, "If the magnet were a sphere the demagnetizing force would be $\frac{4}{3}\pi I$." The symbol I here, like $\mathfrak{I}$ in the formula above, means the intensity of magnetization.

Now, according to Maxwell, $\mathfrak{H}$[2] is not merely the original magnetizing force, which we will call $\mathfrak{F}$. It is this minus the *demagnetizing* force, which in this case is $\frac{4}{3}\pi I$. We have, therefore, from Maxwell,

[1] Maxwell, art. 428. [2] Maxwell, arts. 398 and 426.